REMARKS

The Present Invention

The present invention pertains to a semiconductor base in which a GaN crystal laterally grown from an upper part of a convex part and a GaN crystal grown from a concave part of a substrate are joined to cover a concavo-convex surface. The resulting semiconductor base has a low dislocation area and a high quality GaN crystal.

The Pending Claims

Claims 22-35 are pending.

The Amendments to the Claims

The claims have been amended to point out more particularly and claim more distinctly the present invention.

Claims 1-10 have been canceled. Claims 11-21 had been canceled previously.

Claims 22, 23, 25, and 27 have been amended. These amendments are supported by the specification at, for example, page 10, line 13, and Examples 1, 5, and 7-13.

Claim 26 has been amended and is supported by the specification at, for example, page 5, lines 10- 32, page 10, line 13, and Examples 8, 11, and 13.

Claims 28 and 29 have been amended to make it more clear that the recited concavo-convex surface refers to the second semiconductor crystal layer.

Claims 30-33 have been added and are supported by the specification at, for example, page 15, line 7, through page 16, line 19.

Finally, claims 34 and 35 have been added and are supported by the specification at, for example, page 8, lines 29-32 and page 20, lines 20-23.

No new matter has been added by way of these amendments.

Discussion

Applicants submit herewith an Information Disclosure Statement that includes references AD-AG (U.S. Patent Nos. 6,091,085, 6,335,546, 6,426,519, and 6,617,182, respectively), as well as AH and AI (Japanese patent application counterparts of references AE and AG). Claims 22-35 are patentable in view of these references, whether considered alone or in combination with the other references of record.

(A) U.S. Patent No. 6,091,085 (Lester et al.)

Lester et al. discloses a GaN-based light emitting diode (LED). According to Lester et al., the GaN crystal grows only in the holes of an SiO_2 mask until the GaN layer reaches the top of the holes. At this point, the GaN crystal will grow both upward and laterally, nucleated by the material in the hole. The shape of the extension of the GaN layer on top of the mask will be pyramidal (col. 4, lines 48-63, and Figures 3 and 4). Therefore, the device of Lester et al. is different than that of the present invention. More specifically, Lester et al. does not teach or suggest a device in which the GaN crystal grows from the upper part of the convex part of the concavo-convex surface *and* a surface of the concave part as starting points, whereupon the crystal grown laterally with the upper part of the convex parts as a starting point and the crystal grown from the surface of the concave part are joined to cover the concavo-convex surface of the substrate. Thus, Lester et al. does not teach or suggest all of the elements of the pending claims. Accordingly, the present invention as defined by pending claims 22-35 is patentable in view of Lester et al.

(B) U.S. Patent No. 6,335,546 (Tsuda et al.)

Tsuda et al. discloses a nitride semiconductor that includes a substrate with a growth surface, a convex portion, a concave portion that is formed on the growth surface, and a nitride semiconductor film grown on the growth surface. A cavity is formed between the nitride semiconductor film and the substrate in the concave portion (see abstract and Figure 8). Tsuda et al. discloses that "the nitride semiconductor **124** above the groove **115** ... is not under any influence from the processed substrate **100** ..." (col. 5, lines 9-14). Tsuda et al. further states: "The presence of the nitride semiconductor film **124** ... makes it possible to relax the stress-induced strain in the nitride semiconductor film **123** on the convex portions **114** due to any lattice mismatching and/or difference in thermal expansion coefficient between the nitride semiconductor film **124** and the processed substrate **100**. Thus, ... the threading dislocations ... can be reduced as compared to the case of growing crystals on a flat surface. Furthermore, in the case of forming a thick nitride semiconductor film, cracks can be minimized due to the reduced stress, unlike in the prior art." (col. 5, lines 14-28).

Therefore, in the semiconductor device of Tsuda et al., it is essential that the crystal on the groove be free of any influence by the substrate. To achieve this, the semiconductor device of Tsuda et al. requires a cavity (**116**). This feature is in direct contrast to the present invention in which a crystal grown laterally from the upper part of the convex part and a crystal grown from the concave part are joined to cover the concavo-convex surface. In other

words, the semiconductor device of the present invention does not contain a cavity. See, for example, Figures 3(b) and 3(c) of the instant application. Accordingly, the present invention as defined by pending claims 22-35 is patentable over Tsuda et al.

(C) U.S. Patent No. 6,426,519 (Asai et al.)

Asai et al. discloses an epitaxial growth substrate comprising a base material and an $Al_xGa_yIn_zN$ film ($x+y+z=1$; $x>0$; $y, z \geq 0$) (col. 1, lines 6-10). Since x is greater than 0, Asai et al. does not teach forming GaN crystals on the substrates. Moreover, Asai et al. teaches that Al is an "indispensable component with low dislocation density and good properties" (col. 2, lines 49-54). All of the pending claims requires the use of a GaN crystal. Accordingly, the present invention as defined by pending claims 22-35 is patentable in view of Asai et al.

(D) U.S. Patent No. 6,617,182 (Ishida et al.)

Ishida et al. discloses a semiconductor device that includes a crystalline substrate including a primary surface and a crystal plane provided within the primary surface so as to have a surface orientation different from a surface orientation of the primary surface, a semiconductor layered structure grown over the crystalline substrate, and an active region provided at a portion in the semiconductor layer structure above the crystal plane (see abstract). A semiconductor layer in a semiconductor layered structure is grown in a certain direction in accordance with the shape of an upper surface of an underlying semiconductor layer including *a primary surface* and *a tilted surface* (col. 2, lines 13-17).

According to Ishida et al., the direction of the dislocation line is changed by the presence of a tilted surface. To achieve this, a continuous semiconductor layer is grown over the entire surface of a concavo-convex surface *from a flat part of the upper side of the convex parts to the bottom of the concave part via a tilted surface formed on the side of the convex parts* (col. 6, lines 37-48, and Figure 1). Thus, the crystal growth in the device of Ishida et al. is different than that of the present invention, which involves a semiconductor crystal that starts to grow separately and joins to cover the concavo-convex surface of the substrate. Therefore, the present invention as defined by pending claims 22-35 is patentable in view of Ishida et al.

Conclusion

The application is considered in good and proper form for allowance, and the Examiner is respectfully requested to pass this application to issue. If, in the opinion of the Examiner, a telephone conference would expedite the prosecution of the subject application, the Examiner is invited to call the undersigned attorney.

Respectfully submitted,

John Kilyk, Jr., Reg. No. 30,763
LEYDIG, VOIT & MAYER, LTD.
Two Prudential Plaza, Suite 4900
180 North Stetson
Chicago, Illinois 60601-6780
(312) 616-5600 (telephone)
(312) 616-5700 (facsimile)

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